

ATTACHMENT

DEQ Comment 1: Page 1, 1st Paragraph. The purpose of the November 17, 2010 ARKEMA PCDD/PCDF Eco SSL technical memorandum prepared by Integral Consulting for Legacy Site Services was to refine bioaccumulative soil screening level values (SLVs) for PCDDs and PCDFs for the ecological risk assessment, and to provide the basis for identifying hot spot levels. For Total DDX and isomers of DDT, DDD and DDE, EPA's Soil Screening Levels (SSLs) that incorporate bioaccumulation will be used. The additional bioaccumulative chemicals listed in the cover letter of the ARKEMA Ecological SSL memo (e.g. Lindane and isomers, Endrin, phthalates and Aroclors 1248 and 1260) are above risk levels and continue to be chemicals of concern (COCs) at the site. However, DEQ has indicated that although these chemicals are present above acceptable risk levels, current data does not show these chemicals to be present above hot spot levels (defined as 10 times the acceptable risk level).

Legacy Site Services Response to Comment 1: Legacy Site Services agrees that the other chemicals mentioned above do not define hot spot levels at the site. The November 17, 2010 Integral technical memorandum was not intended to address any of these other chemicals. This comment is not relevant to the analysis presented.

DEQ Response Review. Response is noted.

DEQ Comment 2: Page 1

Bioaccumulation in Prey: The ARKEMA PCDD/PCDF Eco SSL memo outlines soil screening level calculations for dioxins and furans using methodologies outlined in EPA's Eco SSL document. The focus is on calculating soil SLVs for two representative receptors, the robin and shrew. Following EPA methodology, there are two options for modeling invertebrate concentrations from soil:

- 1) The use of an empirical regression relationship between soil and earthworm concentration using the results of field studies. While this methodology is included in EPA Eco SSL methodology, the empirical data for dioxins and furans is limited to two studies of 2,3,7,8-TCDD.
- 2) EPA also uses partitioning relationships of worm to soil water (K_{ww}), and water to soil (K_d) to calculate soil to earthworm bioaccumulation factors (BAFs). This approach can be applied to all dioxin and furan congeners using chemical properties such as K_{ow} . The soil properties used are presented in Table 6 of the ARKEMA PCDD/PCDF Eco SSL memo. Based on EPA's methodology, BAFs can be calculated to estimate earthworm concentrations from soil concentrations. These BAFs were not shown in the memo, but are presented in Table 1 of this memo for dioxin and furan congeners.

Table 1: PCDD and PCDF congener specific earthworm bioaccumulation factors (BAFs) calculated using partitioning methodology outlined in EPA’s Guidance for Developing Ecological Soil Screening Levels (Eco SSLs), (EPA, 2005). Chemical and soil properties from the ARKEMA PCDD/PCDF Eco SSL memo were used in the calculation.

PCDD / PCDF Congener	Earthworm BAF
2,3,7,8-TCDD	21
1,2,3,7,8-PeCDD	4
1,2,3,4,7,8-HxCDD	54
1,2,3,6,7,8-HxCDD	125
1,2,3,7,8,9-HxCDD	125
1,2,3,4,6,7,8-HpCDD	73
OCDD	44
2,3,7,8-TCDF	21
1,2,3,7,8-PeCDF	22
2,3,4,7,8-PeCDF	28
1,2,3,4,7,8-HxCDF	125
1,2,3,6,7,8-HxCDF	125
1,2,3,7,8,9-HxCDF	63
2,3,4,6,7,8-HxCDF	125
1,2,3,4,6,7,8-HpCDF	75
1,2,3,4,7,8,9-HpCDF	75
OCDF	174

The ARKEMA PCDD/PCDF Eco SSL memo selects the regression model for 2,3,7,8-TCDD and the partitioning model for the 16 other dioxin and furan congeners. There is some uncertainty in using the regression model for 2,3,7,8-TCDD given the limited data set used to develop the relationship. However, since 2,3,7,8-TCDD is rarely detected at the site (only RBC 7, 8, 9 and 11) and is not a primary driver of total dioxin toxic equivalency (TEQ), the use of either the regression or partitioning model for this congener does not result in significant differences in estimating Total dioxin TEQ

Legacy Site Services Response to Comment 2. Legacy Site Services notes:

- Option 1. That this is two more studies than the modeling approach referenced by DEQ. Also, EPA’s methodology is preferred.
- Option 2. That this statement (“These BAFs were not shown in the memo, but are presented in Table 1 of this memo for dioxin and furan congeners.”) is not correct. The BAFs are presented in last (right-hand) column of Table 6 of the Integral technical memorandum and are expressed as the ‘Model Constant’. This column will be re-labeled in the revised memorandum to clarify its meaning.

- That there is also a high degree of uncertainty in the modeled approach, which is based on numerous variables and supporting studies that also have considerable, but undocumented variability. The empirical studies cited by Sample et al. (1988) and used herein appear to have a high degree of concordance and collectively yield a relationship (power function) with a coefficient of variation (R-squared value) of 0.94. This coefficient of variation indicates that 94 percent of the variability in the worm tissue data is explained by soil concentration. Consequently, pursuant to EPA guidance the available studies appear sufficient to yield an empirical relationship for estimating a soil SLV.

DEQ Response Review. Responses are noted. EPA guidance and methodology includes the use of both the partitioning (BAF) and empirical regression methodology depending on data availability. The empirical regression model is specific to the 2,3,7,8-TCDD congener only. The partitioning model is available to model the bioaccumulation of the other PCDD and PCDF congeners.

Associated with this comment set, Legacy Site Services requested clarification as to whether DEQ intends to use only detected values to assess risk and potential hotspots noting that this memo assumes ½ the detection limit for non-detected values.

DEQ Response. Per the DEQ Final April 1998 Guidance for Ecological Risk Assessment: Levels I, II, III, IV, Legacy Site Services should continue to use one-half the detection limit for non-detected values following as follows “if the data set contains any value classed as a positive detect, then include all non-detect samples in the exposure concentration computation with values of one-half their detection limits.”

DEQ Comment 3: Page 2, 2nd Paragraph. SLVs and Hazard Quotients: It is confusing to present soil screening levels (Table 9, ARKEMA PCDD/PCDF Eco SSL memo) and hazard quotients (HQ) (Appendix 1, ARKEMA PCDD/PCDF Eco SSL memo) at hot spot levels (10X lowest observed adverse effect level (LOAEL) soil SLV). In addition, because a HQ of one in Appendix 1 actually equals a hot spot level, the presentation using only two significant digits masks hazard quotients that approximate unacceptable risk (HQs >1 at the LOAEL SLV). In many cases, these samples show up as hazard quotients of zero in Appendix 1. Instead, hazard quotients should be presented using LOAEL SLVs to allow the reader to identify those samples that represent unacceptable risk (HQs >1) and those at hot spot levels (HQ>10). Sufficient significant digits should be selected such that each hazard quotient shows a value greater than zero.

Legacy Site Services Response to Comment 3. The memo will be revised to express the HQs in context of LOAEL SLVs as requested.

DEQ Response Review. Response is disapproved. SLVs were not revised to represent LOAEL SLVs and hazard quotients for PCDD and PCDF congeners other than 2,3,7,8-TCDD but instead were removed from the document (Table 8 in the Nov. 17, 2010 ARKEMA PCDD/PCDF Eco SSL technical memorandum). Although DEQ identified errors in the application of the congener specific SLVs, DEQ accepted the SLVs calculated by Legacy Site Services in the initial November 2010 technical memorandum. Please see the response to DEQ comment 4 below for the appropriate calculation of total dioxin TEQ.

DEQ Comment 4: Page 3 Dioxin Total Toxicity Equivalency (TEQ): Congener specific soil screening levels are the focus of the technical memorandum, but are inconsistent with how risk is determined for dioxin-like chemicals. Based on a common mechanism of action that involves binding to the aryl hydrocarbon (Ah) receptor, dioxins and furans are evaluated as equivalents to 2,3,7,8-TCDD using toxic equivalency factors (TEFs). Therefore, it is the total toxic equivalent concentrations compared to 2,3,7,8-TCDD acceptable levels that are the focus of the risk assessment. Calculating congener-specific SLVs can give an indication of the congeners driving the dioxin TEQ, but ultimately a total TEQ hazard quotient >1 indicates unacceptable risk, and a total TEQ HQ >10 indicates a hot spot.

In the ARKEMA PCDD/PCDF Eco SSL memo, total dioxin TEQ HQ was calculated by comparing soil concentrations adjusted by mammalian and avian soil toxicity equivalency factors (TEFs) to the empirical regression soil SLVs for 2,3,7,8-TCDD of 1.10E-5 mg/kg and 7.2E-5 mg/kg, respectively (Appendix 1, footnote “b”). This methodology is opposite to the approach presented in the text in the memo (Page 7) that states “because of differences among the congeners in their bioavailability and fate and transport characteristics, it is preferable to use congener-specific equations through an exposure model rather than base it on total TEQ in an abiotic matrix”. Instead, each congener TEQ for soil and earthworms should be used to calculate total TEQ for risk to birds and mammals. The calculated total TEQ is then compared with the 2,3,7,8-TCDD toxicity reference value (TRV). DEQ considers this the correct approach.

Using the correct methodology for calculating total dioxin TEQ, the use of a regression or partitioning model for 2,3,7,8-TCDD makes little difference in the results. This correction will increase the total dioxin TEQ hazard quotients by a factor of approximately 13 to 21 for mammals and 4 to 8 for birds depending on the sample. Table 2 of this memo shows the hazard quotients calculated for each soil composite location. Sample locations with HQ>1 are considered unacceptable risk, and those exceeding 10 times the acceptable risk level (HQ>10) are considered at hot spot levels for dioxin TEQ.

Table 2: Total dioxin toxic equivalency hazard quotients for avian (robin) and mammalian (shrew) exposed to riverbank soil samples.

Sample Composite	Mammalian Total Dioxin TEQ HQ	Avian Total Dioxin TEQ HQ
RBC-1	16	3.8
RBC-2	14	2.4
RBC-2_3	0.8	0.03
RBC-3	470	70
RBC-4	7.0	1.6
RBC-5	91	4.1
RBC-6	15	1.8
RBC-6-03	2.3	0.4

RBC-7	130	26
RBC-8	81	13
RBC-9	210	35
RBC-10	63	9.7
RBC-10-03	4.3	0.6
RBC-11	370	64
RBC-11-03	32	6.8
RBC-12	180	29
RBC-13	59	9.8
RBC-13-01	7.5	1.3

Legacy Site Services Responses to Comment 4.

- Legacy Site Services will revise its analysis based on total TCDD TEQ concentrations in soil for birds and small mammals to support Level II ERA risk calculations. Per DEQ guidance, risks of individual COIs are determined by the formula $HQ > Q$, where HQ is defined as the exposure point concentration divided by the SLV and $Q=5$. The exposure point concentration is defined as the upper 90 percent confidence limit of the mean based as determined using Pro UCL software. Consequently, individual sample locations are not used to determine unacceptable risk to birds and mammals. However, LEGACY SITE SERVICES understands that pursuant to DEQ guidance 10X LOAEL-based SLVs may be used in comparison to individual sample locations in support of a hotspot evaluation.
- Footnote ‘b’ states “HQs for total TEQ are based on comparisons to the SLV for 2,3,7,8-TCDD. All other HQs are based on comparison to congener specific SLVs.”
- Individual congeners have been removed from the analysis to avoid confusion in how to determine a total TCDD TEQ hazard quotient that can be related to a total TCDD concentration in soil.
- Legacy Site Services revised its analysis based on total TCDD TEQ concentrations in soil for birds and small mammals.

DEQ Response Review. Response is disapproved.

- According to DEQ guidance, the use of a $Q=5$ can be used only to convert an SLV based on a no observed adverse effect level (NOAEL) used for threatened and endangered species to a lowest observed adverse effect level (LOAEL) for all other plants and animals. Since the SLVs in the memo are LOAEL based, the 5x factor does not apply.
- Total TCDD TEQ concentrations that consider congener-specific bioaccumulation into prey tissue were not revised according to DEQ comments and continue to be based on the conversion of only soil concentrations using toxicity equivalence factors (TEFs) of PCDD and PCDF congeners to a 2,3,7,8-TCDD toxicity equivalency (TEQ). In EPA’s guidance on the application of toxicity equivalence methodology for polychlorinated dioxins, furans and biphenyls in ecological risk assessment (EPA, 2008), EPA states the following:

“it is imperative that chemical concentrations in abiotic media be converted to concentrations in either the tissues of organisms being assessed or their food through use of appropriate bioaccumulation factors or models **prior** to applying TEFs-WHO98/05. For example, BAFs can be applied to PCDD, and PCDF concentrations in media to obtain predicted concentrations in organisms. It follows that TEQs should generally not be directly based on water, sediment, or soil, since these media are inconsistent with the dosimetry basis for the toxicity equivalence model.”

Legacy Site Services also presents text to this effect (Page 7 of the November 17, 2010 ARKEMA PCDD/PCDF Eco SSL memo).

- The individual congeners SLVs and hazard quotients are needed to confirm the total dioxin TEQ calculations are correct.

DEQ Comment 5: Page 4, 1st Paragraph. Congener Specific Soil SLVs: The ARKEMA PCDD/PCDF Eco SSL memo evaluates both approaches outlined above and ultimately selects using the empirical regression for 2,3,7,8-TCDD and partitioning relationships for the other dioxin and furan congeners. These methods are used to develop congener-specific soil screening levels based on adjusting the LOAEL screening levels for 2,3,7,8-TCDD by the congener-associated TEF. These values are presented in Table 8 of the memo, but are adjusted by an additional factor of 10 to represent hot spot levels. To avoid confusion, Table 8 should instead present the soil screening level values for each congener without the 10-times multiplier. In addition, given uncertainties with the regression based 2,3,7,8-TCDD soil SLVs, modeled results using the partitioning models need to be presented.

Legacy Site Services Response to Comment 5. Legacy Site Services revised its analysis based on total TCDD TEQ concentrations in soil for birds and small mammals. Modeled results for the SLV are presented in Table 7, but are not used, per EPA’s recommendation, to estimate risk or to identify hotspots.

DEQ Response Review. Response is disapproved. It is unclear what EPA recommendation is referred to here. EPA uses bioaccumulation models that include both partitioning (BAF) and empirical regression relationships. Modeled results for total dioxin TEQ using congener-specific bioaccumulation models for this situation is clearly recommended in EPA 2008.

DEQ Comment 6: Page 4, Last Paragraph. Hazard quotients by individual congener are presented in Appendix 1 of the ARKEMA PCDD/PCDF Eco SSL memo by sample location. In this evaluation, soil concentrations for each congener are inappropriately converted by TEFs before they are compared to the soil SLVs. SLVs in Table 8 were developed to be directly compared with congener soil concentrations, not congener TEQs. Therefore, the congener-specific hazard quotients in Appendix 1 are underestimated by a factor of up to 10,000, equivalent to the inverse of the species-specific TEF. These HQs should be corrected and summed to calculate a total TEQ hazard quotient for each sample.

Legacy Site Services Response to Comment 6. An error was found in the spreadsheet and has

been corrected. Also individual congeners have been removed from the analysis to avoid confusion in how to determine a total TCDD TEQ hazard quotient that can be related to a total TCDD concentration in soil.

DEQ Response Review. Response is disapproved. The individual congeners SLVs and hazard quotients are needed to check that the total dioxin TEQ calculations are correct. The total dioxin TEQ hazard quotient should be calculated using congener-specific bioaccumulation from soil into prey. Removing individual congeners from the bioaccumulation analysis will not avoid confusion, and will instead result in an inaccurate evaluation of risk because the bioaccumulation modeling of congeners was not done correctly. EPA guidance specifies that the bioaccumulation of individual congeners needs to be modeled prior to applying TEFs to calculate a TCDD TEQ. Revised congener specific and total dioxin TEQ concentrations and hazard quotients for soil and biota are presented for each sampling location in DEQ's revised Appendix 1. DEQ included the individual congeners in the DEQ revised memorandum.

DEQ Conclusion Bullets. Last Page.

Bullet 1. The tables should be revised to reflect LOAEL soil SLVs for each PCDD and PCDF congener. LOAEL soil SLVs for 2,3,7,8-TCDD should include a presentation of SLVs developed using the partitioning and regression models.

Legacy Site Services Response to Bullet 1. Individual congeners have been removed from the analysis to avoid confusion in how to determine a total TCDD TEQ hazard quotient that can be related to a total TCDD concentration in soil. Consequently, SLVs are not determined for the individual congeners.

DEQ Response Review. Response is disapproved as Legacy Site Services did not make the requested change. The individual congeners SLVs and hazard quotients are needed to check that the total dioxin TEQ calculations are correct. Total dioxin TEQ must be calculated using congener-specific equations throughout an exposure model rather than base it on total TEQ in soil. Revised LOAEL based SLVs (mg/kg dw soil) for individual congeners, including both the partitioning and regression model for 2,3,7,8-TCDD, are presented in Table 8 of DEQ's revised November 17, 2010 memo.

Bullet 2. Total dioxin TEQ should be calculated for each sample location using congener TEQs for soil and earthworm prey. The calculated total TEQ should then be compared with the 2,3,7,8-TCDD toxicity reference value (TRV) to calculate total dioxin TEQ hazard quotients.

Legacy Site Services Response to Bullet 2. Using TEFs, a TCDD TEQ concentration was determined for each congener at each sample location. The TCDD TEQ concentrations were then added to determine a total TCDD TEQ for soils. These were then compared to the 2,3,7,8-TCDD soil SLV to estimate a hazard quotient for each congener at each sample location.

DEQ Response Review. Response is disapproved. Total dioxin TEQ must be calculated using congener-specific equations throughout an exposure model rather than base it on total TEQ in soil. Revised Total dioxin TEQ hazard quotients are presented in Table 9 and Appendix 1 of DEQ's revised November 17, 2010 memo.

Bullet 3. Total dioxin TEQ HQs should be presented for each sample location with appropriate significant digits (non-zero HQs). Sample locations with total dioxin TEQ hazard quotients >1 times the LOAEL SLV should be used to identify areas of unacceptable risk, and hot spots should be identified as sample locations with total dioxin TEQ hazard quotients >10 times the LOAEL SLV.

Legacy Site Services Response to Bullet 3. Per DEQ guidance, risks of individual COIs are determined by the formula $HQ > Q$, where HQ is defined as the exposure point concentration divided by the SLV and $Q=5$. The exposure point concentration is defined as the upper 90 percent confidence limit of the mean as determined using Pro UCL software. Consequently, individual sample locations are not used to determine unacceptable risk to birds and mammals. LEGACY SITE SERVICES understands that pursuant to DEQ guidance 10X LOAEL-based SLVs may be used in comparison to individual sample locations in support of a hotspot evaluation.

DEQ Response Review. Response is disapproved. See DEQ review of the Legacy Site Services response to DEQ Comment4. A $Q=5$ factor is only relevant if the SLV is a no observed adverse effect level. This analysis uses lowest observed adverse effect levels, and therefore it is not appropriate to use the $Q=5$ factor. Total dioxin TEQ HQs for each sampling location are presented in Table 9 and Appendix 1 of DEQ's revised November 17, 2010 memo.

Bullet 4. Congener-specific HQs can be presented for each sample location to inform the drivers of total dioxin TEQ risk. Since SLVs were developed to be compared directly with congener soil concentrations, not congener TEQs, congener soil concentrations should not be converted by their respective TEFs before comparison.

Legacy Site Services Response to Bullet 4. Individual congeners have been removed from the analysis of SLVs to avoid confusion in how to determine a total TCDD TEQ hazard quotient that can be related to a total TCDD concentration in soil. In the revised memo, SLVs are based exclusively on 2,3,7,8-TCDD.

DEQ Response Review. Response is disapproved. See the review of the response to Bullet 2 above. Individual congener bioavailability must be included in the analysis to estimate soil and earthworm total dioxin TEQ rather than base it on a total TEQ in soil only. LOAEL-based congener specific SLVs are presented in Table 8 of DEQ's revised November 17, 2010 memo. The revised Appendix 1 shows congener specific and total dioxin TEQ concentrations in soil and earthworm, total dioxin TEQ dietary dose (mg/kg-day) and associated LOAEL based hazard quotients for each sampling location.

Bullet 5. A figure showing the sampling locations and associated total dioxin TEQ hazard quotients should be included with the revision.

Legacy Site Services Response to Bullet 5. A revised figure showing total TCDD TEQ hazard quotients is included in the attached addendum.

DEQ Response Review. Response is disapproved. A figure showing locations and associated total dioxin TEQ hazard quotients that incorporates congener-specific bioaccumulation (soil and earthworm) is not included (see response to bullets 2 and 3 above). Corrected total dioxin TEQ HQs are shown in a revised Figure 1 in DEQ's revised November 17, 2010 memo.

References:

EPA, 2008. Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment, EPA 100/R-08/004, Office of the Science Advisor, U.S. EPA, Washington, D.C.